Fiscal policy instruments to mitigate climate change – A Belgian perspective

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Introduction

Countries worldwide are increasingly committing to reducing greenhouse gas (GHG) emissions to net zero by mid-century. In that perspective, the European Union anchored its goal of climate neutrality in the European Climate Law – recently approved by both the European Parliament and the Council. In line with the zero-carbon emission goal, the European Commission proposed to raise the EU's ambitions to cut GHG emissions to at least 55 % below 1990 levels by 2030 – which is a substantial increase compared to the current adopted target of at least 40 % (EC, 2020a). However, making sufficient progress to stabilise the climate, to cut global CO_2 emissions along with other greenhouse gases and to reach intermediate goals requires additional action to be taken as is shown by, among others, Parry *et al.* (2021).

Taking into account existing policy measures, Parry *et al.* (2021) illustrate that global CO_2 emission projections will rise from around 30 billion tonnes in 2020 to 37 billion by 2030. However, limiting global warming to 2 °C and ideally to 1.5 °C above pre-industrial levels requires global CO_2 emissions to be cut by between 10 and 60 percent. Cutting emissions at this rate requires significant additional government measures, even if countries commit to their Nationally Determined Contributions [1] set out in the Paris agreement. Parry *et al.* (2021) further calculate that the extra measures to be taken are equivalent to the introduction of a global carbon tax – starting at $ 15 per tonne of CO_2 and rising steadily thereafter towards $ 75 per tonne of CO_2 in 2030 [2].

The need for tougher climate policy is confirmed when looking at the EU level. To reach climate goals, the EU is counting on its European Emissions Trading System (EU ETS), which will be discussed later in the article. Backing up the EU ETS, an "effort-sharing" mechanism (ESD) has been put in place with binding national emission targets for non-EU-ETS sectors (i.e. road transport, non-industry heating, agriculture and waste) [3]. Targets vary across Member States and take into account differences in economic activity as well as cost-efficiency considerations. Based on 2019 estimates by the European Environment Agency (EEA), most EU countries will miss their 2030 ESD targets, often by a long way. In the case of Belgium, the 2030 ESD-target amounts to a 35 % reduction of GHG emissions with respect to the 2005 level, whereas with existing policy measures the reduction is estimated to be at around 12 %.

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1 Nationally Determined Contributions (NDCs) embody efforts that countries intend to make to achieve the objectives of the Paris Agreement. They are updated every five years and contain information on targets, policies and measures for reducing national emissions (UN, 2021).

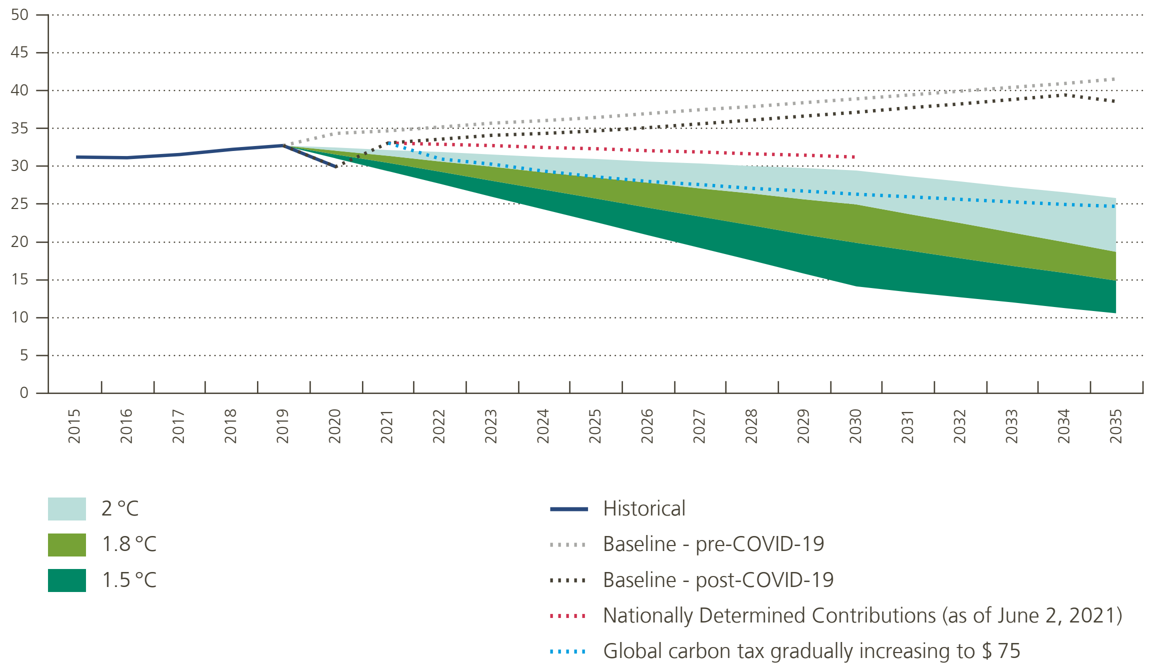
2 To be on track to stabilise global warming to "well below" 2 °C, the tax should rise further beyond 2030.

3 The EU's current Effort Sharing Regulation (EU 2018) imposes binding annual GHG emission targets for Member States for the period 2021-20230. These targets correspond with an EU-wide emission reduction target of 29 %. As part the EU's more ambitious target of achieving net emission reductions of at least 55 % by 2030, the EC is proposing a series of amendments to the Effort Sharing Regulation in order to increase the EU-wide emission reduction target for the Effort Sharing sectors to 40 % by 2030.

Chart 1

Additional policy action needed to tackle climate change

(billion tonnes CO_2 emission per year)

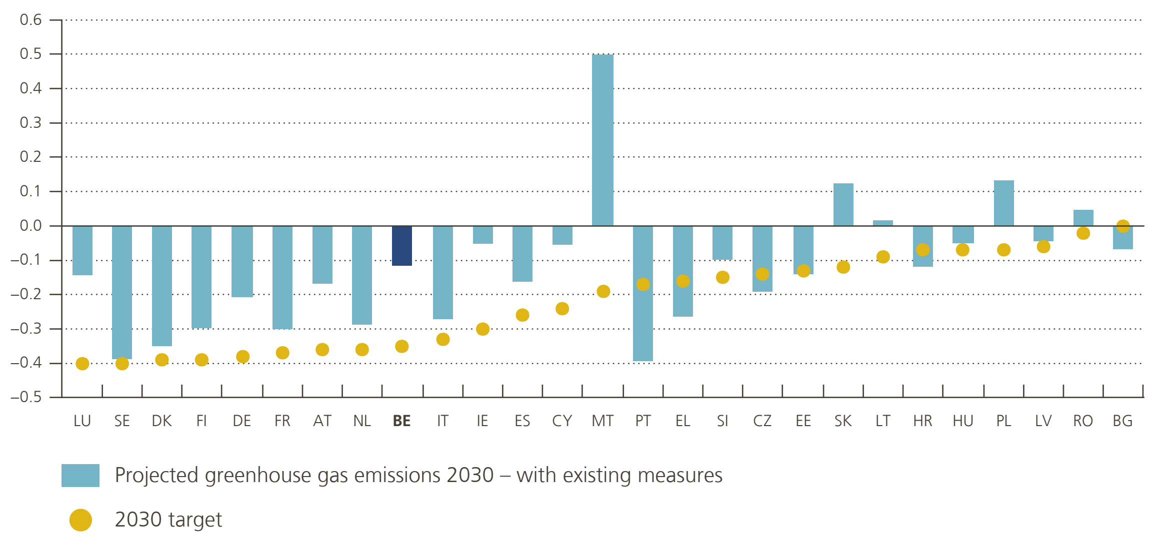


Source: Parry *et al.* (2021).

Chart 2

Expected progress towards ESD targets

(% change compared to 2005)



Sources: EEA, EC.

This article discusses fiscal policy instruments and their role in reaching the proposed climate goals. The focus is therefore on mitigation instruments, that aim at reducing greenhouse gas emissions, and not on adaptation policies, that cope with the consequences of climate change. We investigate different environmental instruments in Belgium, with particular attention to fiscal policy instruments that affect the private cost of emitting CO_2, also called market-based instruments. The remainder of the article is structured as follows. Section 1 gives an overview of different types of environmental policy instruments and discusses the rationale for market-based instruments. Section 2 gives a short discussion of CO_2 emissions in Belgium, whereas section 3 analyses different Belgian fiscal policy instruments and their cost-effectiveness. In section 4, we look at the distributional consequences of environmental policies and section 5 concludes.

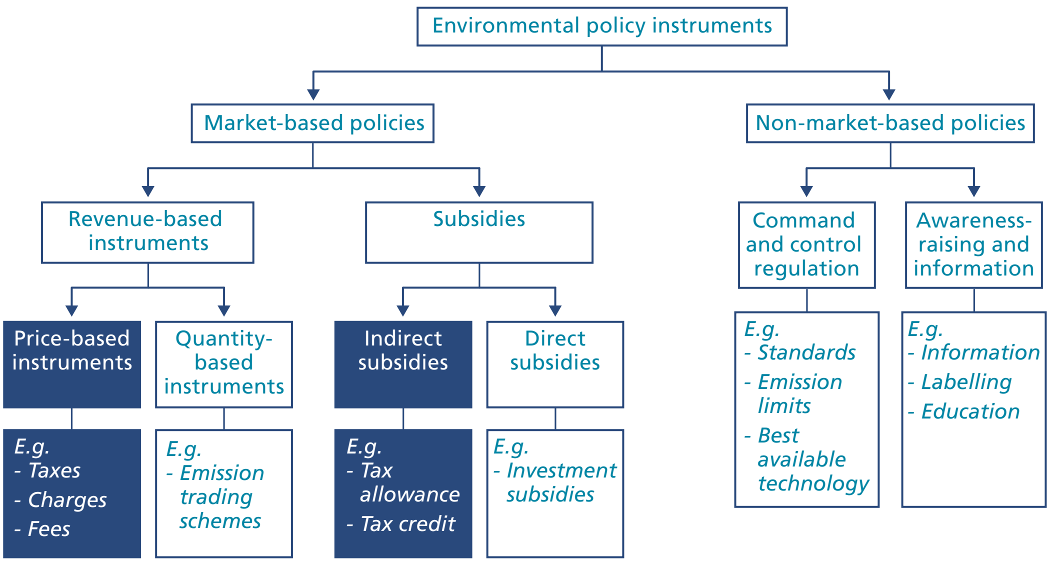
1. The rationale for environmental taxation

1.1 Typology of environmental policy instruments

Governments have a wide range of instruments available for mitigating climate change. As illustrated in Figure 1, they can be divided into different categories. Two basic groups of instruments can be distinguished: the market-based or fiscal instruments on the one hand and the non-market-based instruments on the other hand (EC, 2020b). Market-based instruments are also called incentive-based policies because they provide polluters with market incentives to reduce pollution, by pushing up the relative price of pollution. Basically, these instruments increase the opportunity cost of polluting by making environmentally undesirable behaviour more expensive – the revenue-based instruments – or by promoting environmentally desirable behaviour – government subsidies. Typical revenue-based instruments are either price-based like an explicit carbon tax that directly raises the price of pollution or quantity-based instruments like an emission trading scheme. The latter directly reduces pollution and by allowing trading in emissions effectively raises the cost of polluting. In general, fiscal

Figure 1

Typology of environmental policies



Source: EC (2020b).

instruments give polluters a lot of flexibility as to how they can reduce their emissions and who should reduce pollution. This article will focus on market-based instruments.

The non-market-based policies mainly consist of command-and-control regulations and softer instruments such as raising public awareness. Command-and-control regulations can take a variety of forms but in general they are less flexible than fiscal instruments. One example is the existence of a technology standard which requires polluters to install a certain, more ecological, technology. As a consequence, firms get no incentive to look for cheaper or more efficient ways to reduce pollution. Therefore, a technology standard is unlikely to be cost effective.

In addition, one could also introduce a performance standard – setting an emission goal for each polluter – which is more flexible and cost-effective than a performance standard. However, as a performance standard sets a pollution reduction goal for each producer, the effort of reducing pollution cannot be shifted to firms that can achieve it more cheaply. The next section will show how cost-effective pollution reduction can be obtained when using fiscal instruments.

1.2 Theoretical framework [1]

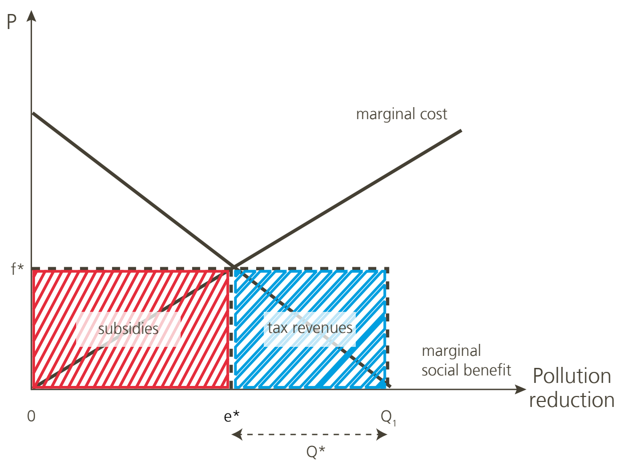
As there are negative external costs accompanying certain forms of production and consumption, that are not borne by the private producer or consumer, pollution in the economy is above its socially efficient level. Putting a price on pollution and thus internalising the environmental costs when making producer and consumer decisions can lead to the socially efficient amount of pollution reduction. In that sense, it should be noted that, from an efficiency perspective, the aim is not necessarily to have zero pollution, but rather a level of pollution that is acceptable in economic terms, i.e. taking into account the costs for current and future generations (Van Cauter *et al.*, 2009).

Putting a price on pollution can be done directly by taxing each unit of pollution – a Pigouvian tax – or by subsidising each unit of pollution reduction – a Pigouvian subsidy. Both instruments can lead to the market efficient outcome as is shown in chart 3.

1 The overview of the theoretical framework is mainly based on Harvey *et al.* (2010).

Chart 3

The introduction of a Pigouvian tax or subsidy can trigger efficient pollution reduction



Let us assume that the production of a certain product is accompanied by some degree of pollution, e.g. the emission of CO_2 into the atmosphere. The cost for producers of reducing one unit of pollution is represented by the rising marginal cost curve, while benefits to society are depicted by the declining marginal social benefit curve. With no government intervention in place, producers will not reduce emissions (point 0 in chart 3), and there will be Q1 units of pollution. The maximum amount of pollution reduction is therefore equal to Q1.

When the government decides to tax each unit of pollution, pollution is reduced as long as the tax per unit of pollution exceeds the cost producers face to reduce one extra unit of pollution. Producers will therefore cut pollution to the point where the tax equals the marginal cost. The exact choice of the level of taxes per each unit of pollution is thus very important. To reach the market efficient level of pollution reduction, represented by e*, the level of tax per unit of pollution, f*, should be chosen so that the marginal private cost of producing a certain product equals the marginal social cost incurring all environmental costs[1]. It is interesting to note that at the efficient point e*, there is still some pollution left (Q*), which is equal to maximum amount of pollution reduction Q1 minus the realized reduction in pollution e*.

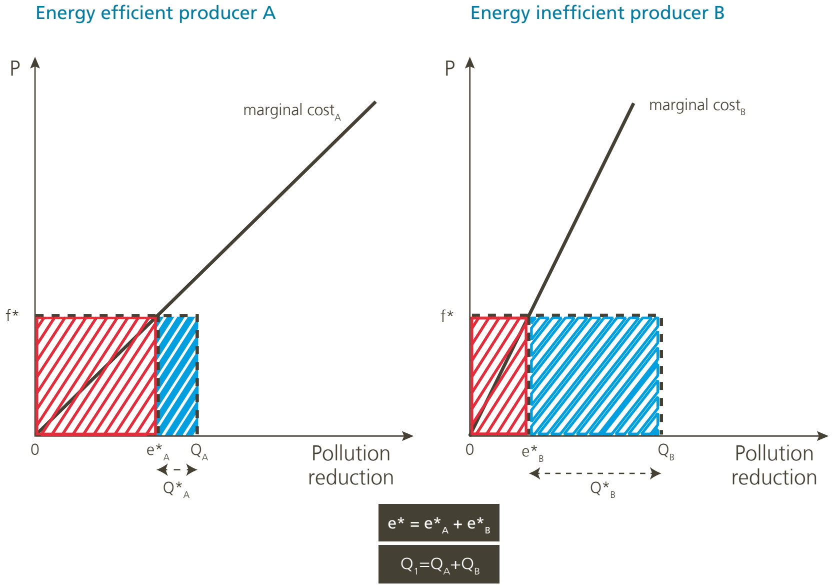
The same efficient amount of pollution reduction e* can also be obtained by giving subsidies to producers for cutting their pollution. If producers receive a subsidy equal to f* for each unit of pollution reduction, they will cut pollution to the point where the subsidy received equals the marginal cost they face for reducing one extra unit of pollution. Again, this leads to the same efficient amount of pollution reduction e* if the subsidy f* is determined adequately.

Although the introduction of a Pigouvian tax and subsidy can result in the same market-efficient outcome, the public finance or distributional consequences differ importantly. With an environmental tax, government revenues increase as producers have to pay taxes for the amount of pollution they still cause – the corresponding tax revenue is represented by the blue shaded area in chart 3 – while when giving subsidies to polluting producers, government expenditure rises – the corresponding budgetary cost is represented by the red shaded area. In the first case, the polluter pays society, while in the second, society pays the polluter not to pollute.

1 As illustrated in Chart 3, this is equal to the point where the marginal cost of reducing pollution equals the marginal social benefit of the reduction in pollution.

Chart 4

A Pigouvian tax or subsidy is cost-effective



From a public finance perspective, a Pigouvian tax is thus more favourable. It should be noted that a thorough analysis of the tax incidence is needed to get a full picture of the (re)-distributional impact of taxes and subsidies. Who finally bears the tax burden or takes advantage of the subsidy depends on how taxes or subsidies feed into consumer prices and depends on market structure, demand and supply elasticities, etc.

One important feature of a Pigouvian tax or subsidy is its cost-effectiveness, meaning pollution is reduced at the lowest possible cost. We assume that the economy consists of two producers, i.e. an energy-efficient producer A and an energy-inefficient producer B. This is illustrated by chart 4, where producer A faces a lower marginal cost for reducing pollution than producer B. For a given Pigouvian tax or subsidy f*, A will reduce pollution much more than B and pollution will first be reduced where the marginal cost is the lowest. Of course, one may ask whether it is fair that A reduces pollution much more than B? It is, because A is also rewarded for being much more efficient. If a Pigouvian tax is installed, A will have to pay less tax (smaller blue shaded area) and if a subsidy scheme is in place, A will get more money from the government (bigger red shaded area).

It should also be noted that a Pigouvian tax or subsidy on pollution is only effective if the amount of pollution can be monitored adequately. Some forms of pollution like GHG emissions are easy to monitor, while for others like chemical waste this is more difficult or costly. In the latter case, a command-and-control approach like a technology standard might be more efficient, because it is relatively easy to monitor whether a firm has installed the technology.

Finally, the efficient level of pollution reduction e* can also be obtained by installing an emission trading system, i.e. for each unit of pollution that is emitted, producers need to submit a government-issued permit. Instead of deciding on the size of the emission fee, governments now need to choose the total permits they want to issue. So, they directly limit the permits to Q*, in order to reach the efficient level of pollution reduction e*. If then polluters are allowed to trade permits, the outcome will also be cost-effective with the market price of the permit equal to f* which is the same as the Pigouvian tax on pollution. From an efficiency standpoint, the initial allocation of permits among producers does not matter at all[1], but it affects the income distribution between polluters.

2. Carbon emissions in Belgium

In 2018, a total amount of more than 130 million tonnes of GHG – expressed in CO_2 equivalent numbers – were emitted by Belgian resident economic units, including households[2]. In per capita terms, this implies emissions of 11.6 tonnes per person. From a European perspective, this means a slightly better performance than neighbouring countries like the Netherlands and Germany, but not as good as France, which has one of the lowest emissions per capita in the EU. When comparing the GHG intensity of our economy in terms of GDP, Belgium is performing much better and even finds itself among the most energy-efficient EU countries. As such, the relatively high Belgian emissions per capita are not the consequence of being relatively energy-inefficient but the result of high economic activity.

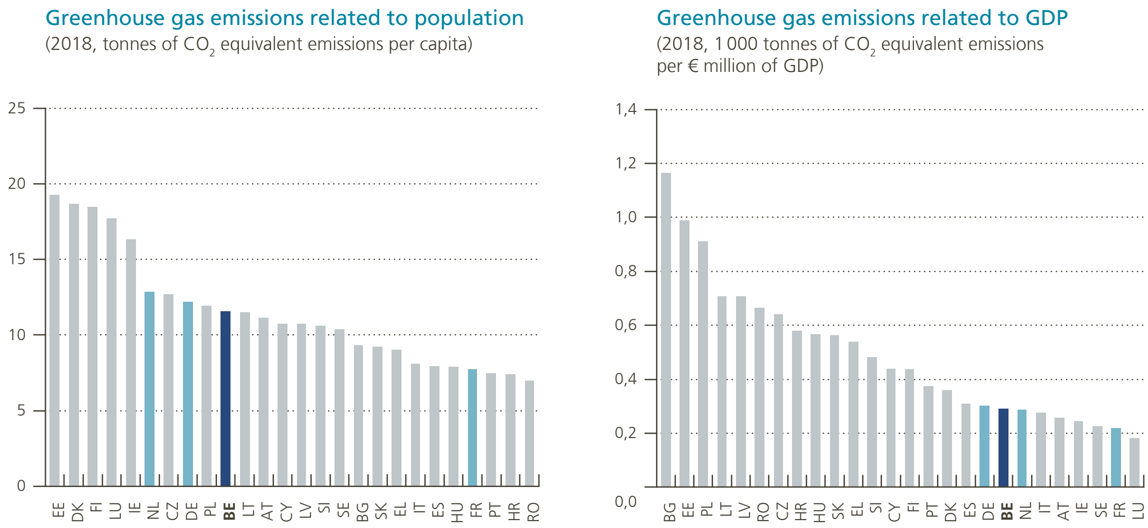
Carbon emissions account for approximately 86 % of GHG emissions in Belgium in 2018. About one-quarter comes from households, with heating and/or cooling of residential dwellings and transport as the main polluting activities. As far as enterprises are concerned, large differences are found between branches of activity. In 2018, the industry and market services branch of activity together accounted for about two-thirds of Belgian total emissions. A more detailed overview of Belgian CO_2 emissions and how they have changed over time can be found in Burggraeve *et al.* (2020).

1 This is the case if the market for permits is a competitive market.

2 A unit is said to be a resident unit of a country when it has a centre of economic interest in the economic territory of that country. As such, emissions from resident units' activities are recorded, regardless of where they occur.

Chart 5

Greenhouse gas intensity [1]



Source: Eurostat.
1 Including emissions from the combustion of biofuels.

Finally, one should be aware that any attempt to fully assess the Belgian burden on global warming must also take into account CO_2 emissions generated abroad in order to produce goods and services that are used or consumed by domestic companies and households and correct for emissions made for goods and services which are later exported and finally used elsewhere (Burggraeve *et al.*, 2020).

3. Belgian fiscal policy instruments to mitigate climate change

In this section, we will analyse whether Belgian market-based policy instruments are effective in terms of mitigating climate change. We will do this by evaluating how these policies succeed in correcting inefficient market outcomes by putting a price on carbon emissions.

3.1 Revenue-based fiscal instruments

To reduce pollution, environmental taxes should ideally have the actual level of pollution as their tax base, implying that the tax can directly be linked to the damage done to the environment. When it comes to taxing the use of combustible energy sources, the amount of carbon emitted into the air is the correct tax base. Belgium does not have a direct carbon tax but there is one in other European countries like Sweden, Denmark and France [1]. However, based on existing Belgian fiscal instruments, an implicit carbon price signal could be calculated. For that, we rely on work done by the OECD.

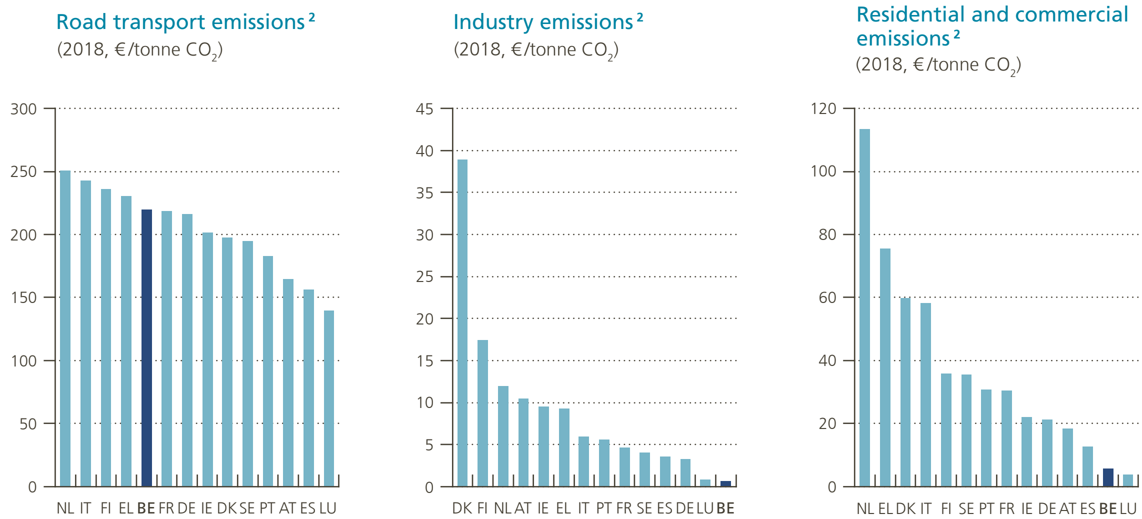
1 An overview of international carbon pricing initiatives is given by the World Bank's Carbon Pricing Dashboard (Carbon Pricing Dashboard | Up-to-date overview of carbon pricing initiatives, worldbank.org).

In its “Taxing Energy Use” publications, the OECD calculates effective carbon tax rates for different combustible energy sources used for different activities. More specifically, they convert taxes on energy use and direct taxes on CO_2 emissions from energy use into tax rates per tonne of CO_2, by taking into account the carbon content of the energy source and by correcting for applicable tax exemptions, rate reductions and tax refunds (OECD, 2019).

For Belgium, the OECD considers existing fuel excise duties and the EU ETS system to determine the effective carbon price signal for different energy sources. Taking the price of a European Union Emission Allowance (EUA) into account is relatively straightforward as EU ETS is designed to price directly the amount of pollution caused by the electricity and industry sector, i.e. firms in energy-intensive industries have to buy emission rights for the amount of CO_2 they send into the atmosphere[1]. In the case of fuel excise duties, it is a bit more complicated. When calculating their contribution to the effective carbon tax rate, the excise duty per unit for each CO_2-emitting energy source is fully converted into a tax per tonne of CO_2 emitted due to the use of the energy source. This means that the excise duty is fully labelled as an energy tax as the scope for behavioural responses is determined by the calculated tax base. Of course, there are also other elements than can explain the exact excise duty rate. For example, in the case of excise duties on different energy sources used in road transport, the level of the tax rate should be chosen not only to correct for negative externalities coming from pollution but also to take into account congestion and the cost of using road infrastructure. Finally, it should also be noted that VAT or sales taxes are not included as they generally apply equally to a wide range of goods and do not change relative prices between energy sources (OECD, 2019).

Chart 6

Average effective carbon tax rates in a European perspective[1]



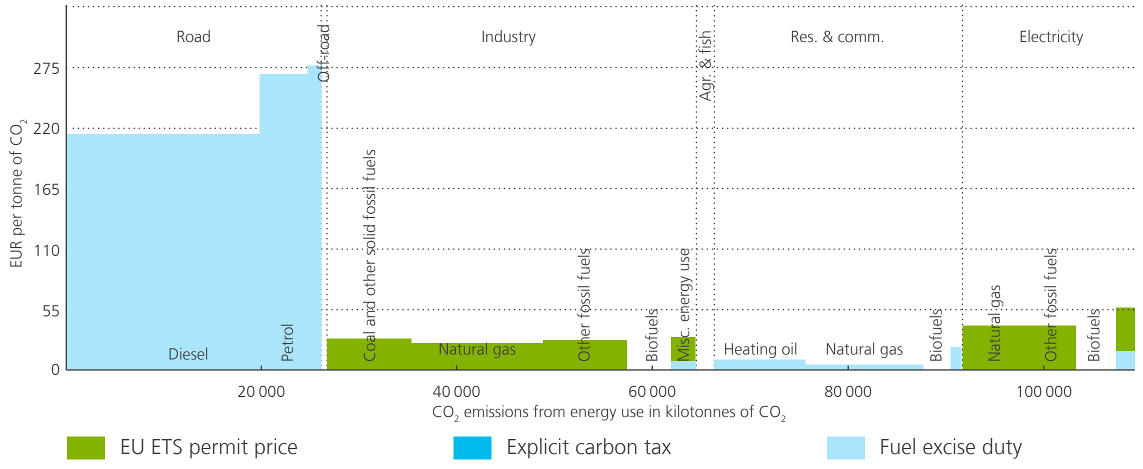
Source: OECD (2019).
1 In these figures, the impact of EU ETS is not taken into account.
2 Including emissions from the combustion of biofuels.

A comparison of effective CO_2 price signals across different European countries immediately points up a wide dispersion across countries and between activities. In general, road transport emissions are taxed the highest in terms of actual CO_2 taxation; this is also the case in Belgium, that ranks in the upper half of the European

1 It should be noted that determining the precise ETS coverage for specific subsectors can require detailed work especially in countries where the industry and power sector is not dominated by facilities above the EU ETS threshold for inclusion. Also note that EU ETS applies to emissions, not fuels, which requires estimating the fuel mix of facilities covered by the EU ETS to be able to estimate instrument overlap.

Chart 7

Detailed effective carbon tax rates in Belgium[1] (€ per tonne of $C0_2$, 2021)



Source: OECD (2022, forthcoming).

1 Taxes on energy use and greenhouse gas emissions, as applicable on 1 April 2021 (for EU ETS this implies a permit price of € 44 per tonne CO_2), are assigned to energy use data adapted from the IEA, World Energy Statistics and Balances, which is also used to calculate CO_2 emissions from energy use, by applying the appropriate conversion factors. The latest available energy use and emissions data was from 2018, which was used as a proxy for the 2021 tax base.

league table. Industry emissions, on the other hand, are not taxed very much in most EU countries[1]. Belgium even ranks lowest here, with barely any levy applied apart from the ETS. For emissions from residential and commercial heating, the picture is more dispersed, with a relatively high effective tax rate in the Netherlands, but relatively low rates in France and Germany. Here too, Belgium scores very badly.

Chart 7 shows a more detailed analysis of the effective taxation of carbon emission in Belgium for different sectors of activity and different energy sources. Below, we will focus on the resulting carbon price signals for each sector of activity.

Taxing emissions from road transport

As can be seen from chart 7, the road transport sector accounts for almost a quarter of total CO_2 emissions originating from energy use. Compared to other European countries, diesel is taxed the highest in Belgium whereas the tax rate for petrol (gasoline) is somewhat higher in neighbouring countries. In most European countries, diesel enjoys a discount as it is taxed at lower rates than petrol. Belgium has had no diesel discount since the end of 2018 and both motor fuels now have the same tax rate per litre. From a climate perspective, taxing diesel at higher rates would be sound as CO_2 emissions per litre for diesel are higher than for petrol. However, and as mentioned by the OECD (2019), this is challenging considering that many governments have long encouraged consumers to buy diesel vehicles.

When converting the excise duty rates on motor fuels into their respective carbon price signal, one can see that the price of pollution – the emission of CO_2 – varies significantly across motor fuels. So, the tax system is not environmentally neutral with respect to the use of energy sources. Although both diesel and petrol have the same excise duty rate, the effective carbon tax rate for the use of petrol is almost 20 % higher, confirming that diesel is more polluting in terms of CO_2 emissions per litre. Moreover, existing Belgian fiscal legislation provides a partial repayment of the excise

1 Taking into account the impact of EU ETS – which is not the case with the OECD (2019) numbers – would of course increase the average effective carbon tax rate in the industry sector. A first analysis, that allows for the impact of EU ETS can be found in OECD (2021). Of course, the taxation of industry emissions including EU ETS is still significantly below the taxation of road transport emissions.

duty on diesel for professional use[1] in order to align the excise duty with the European minimum rate. Importantly, this exemption is not just limited to professional users whose vehicles are registered in Belgium but also applies to all hauliers that buy diesel as a motor fuel on Belgian territory (FPSF, 2021). The effectiveness of such a policy measure in terms of boosting the competitiveness of Belgian transporters could therefore be questioned. However, its budgetary impact is not negligible as, according to the FPSF (2020), the repayment was estimated to have a budgetary cost of € 733 million in 2019. Recently, the federal government announced that – starting from 2022 – it will slightly reduce the partial repayment of excise duties on professional diesel.

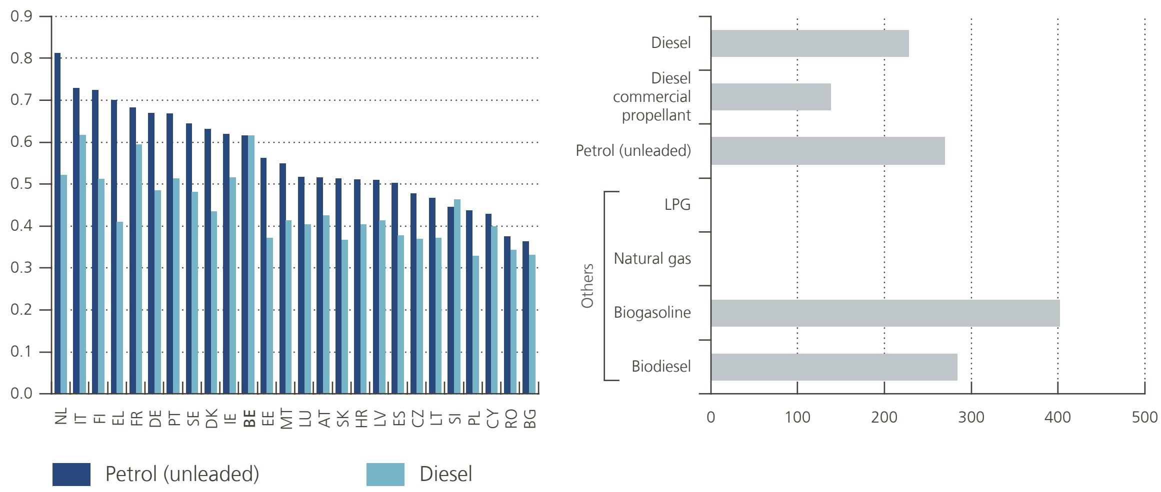
Finally, it is important to stress that the carbon price signal given to road transport is – at least – partially offset by the beneficial tax treatment of company cars which leads to more car use. Especially in combination with a company fuel card, the cost of driving is fully externalized as the marginal cost for the individual of 1 extra kilometre is 0. As such, the cost of carbon emissions due to car use is not borne by the final polluter. According to Laine and Van Steenbergen (2017), the budgetary cost for the Belgian federal government of this environmental unfriendly measure amounts to around € 1,5 billion a year.

Chart 8

Taxing road emissions

Motor fuel excise duties in an European context[1]
(2021, € per litre)

Effective carbon rates differ across motor fuels in Belgium
(2021, €/tonne CO_2)



Sources: EC (2021), OECD (2022, forthcoming).

1 If different rates exist, the one with the highest sulfur content is taken. Potential discounts for the professional use of diesel are not taken into account.

Taxing residential and commercial emissions

Residential and commercial emissions are mainly the consequence of the heating of dwellings. When it comes to the taxation of heating oil as energy source, chart 9 shows that excise duties in Belgium are negligible both in absolute terms and compared to other European countries, the reason being that, in Belgium, only an inspection fee and a levy on energy needs to be paid. When looking at the average effective taxation of CO_2,

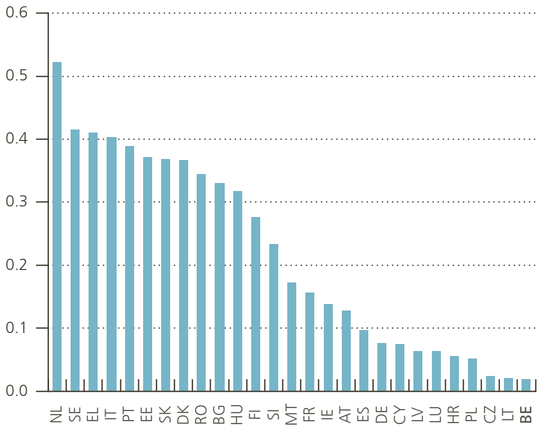
1 Diesel is considered as professional diesel when it is used as an energy source for taxis, motor vehicles intended for the transport of disabled persons, motor vehicles having more than 8 seats – excluding the driver's seat – intended for the transport of passengers, and vehicles with a maximum authorised mass equal to or exceeding 7.5 tonnes and which are exclusively intended for the carriage of goods by road (FPSF, 2021b)..

it is confirmed that the price signal in terms of taxing pollution is very low – especially when comparing this with the CO_2 taxation of energy source for other activities. Moreover, the effective taxation of CO_2 emissions from natural gas used for heating dwellings is even lower than for heating oil. Existing Belgian tax rates on energy sources for heating barely touch the amount of pollution caused and do not give a significant price signal that internalises the cost of pollution and promotes more environmentally-friendly energy sources.

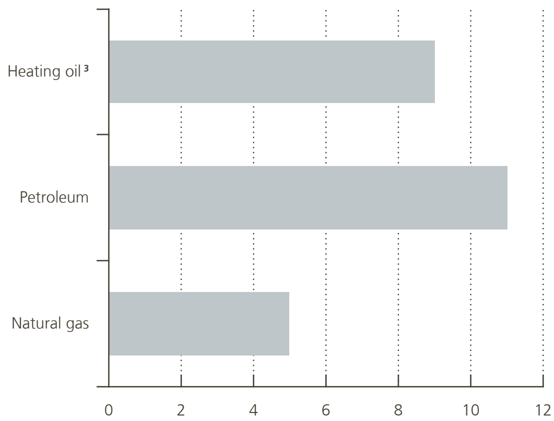
Chart 9

Taxing residential and commercial emissions

Excise duties heating oil in an European context [1]
(2021, € per litre)



Effective carbon rates differ across heating fuels in Belgium [2]
(2021, € / tonne CO_2)



Sources: EC (2021), OECD (2022, forthcoming).
1 When different rates apply, the one for the fuel with the highest sulphur content is taken.
2 For non-professional use.
3 Excluding biofuels.

Taxing industry emissions

Greenhouse gas emissions from the industry sector account for one-third of total Belgian emissions from energy use. Their implicit cost in terms of effective carbon taxation is solely determined by the presence of the European Emission Trading System (EU ETS).

Companies that are bound by EU ETS need to obtain emission allowances covering their carbon emissions. EU ETS is a large-scale "cap and trade" system designed to reduce greenhouse gas emissions, with total emissions controlled by a cap and where a market is created allowing firms to trade emission allowances.

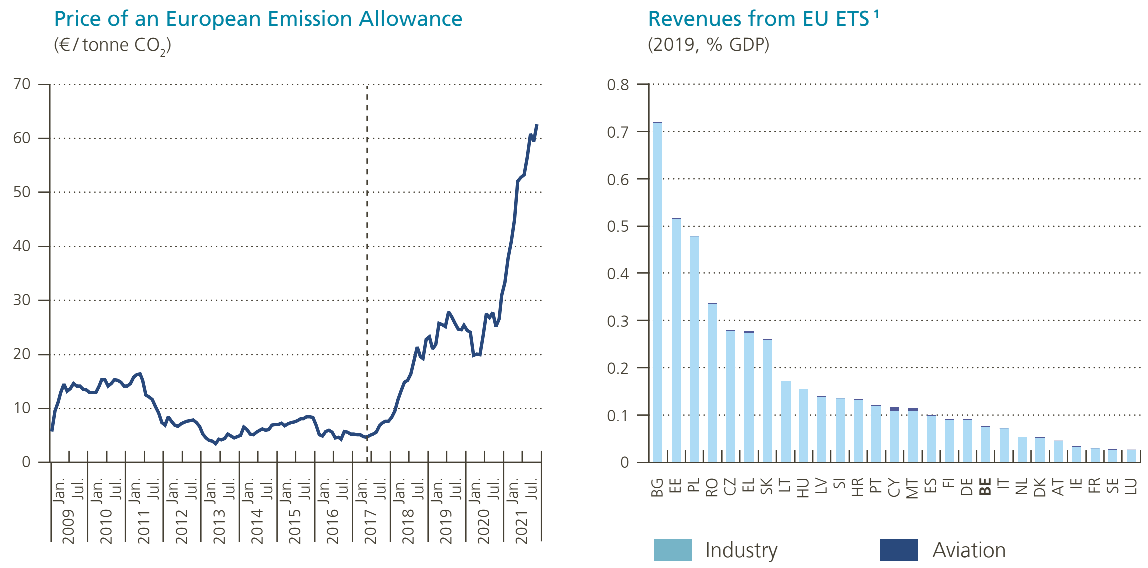
The EU ETS was launched in 2005 by the European Union and has been reformed during different trading phases. From phase 1, the EU ETS covered GHG emissions from the most GHG-intensive sectors in the power and manufacturing industries. In 2012, the scope was expanded to cover CO_2 emissions from the aviation sector as well – although limited to flights within the European Economic Area. From phase 3, the sectoral scope was further expanded to other sectors such as aluminium and other chemicals (EC, 2015). Currently, EU ETS regulates emissions from nearly 11 000 power plants and manufacturing plants as well as around 600 aircraft operators (EC, 2020c) [1].

1 According to the EC's Carbon Market Report (EC, 2020c), it covers around 38 % of the EU's GHG emissions.

Emission allowances are given to firms either through auctioning or for free. The amount of emission allowances an installation gets for free each year is determined before the start of a regulatory cycle using information from a reference period and it is determined by three factors: (i) the size of the installation – the amount of free emission allowances is proportional to the production of the installation, (ii) the sector's emission efficiency benchmark, which forms the upper limit of the amounts received for free as it shows with how few emissions it is possible to produce the product and (iii) the sector the firms operates in, i.e. sectors with a higher risk of carbon leakage receive a higher share of free allowances[1]. Finally, a share of allowances is also set aside in the New Entrants' Reserve for free allocation to new firms.

Chart 10

The European Emission Trading System



Sources: De Jonghe et al. (2022), EC (2020c), Refinitiv.
1 An EU ETS revenue year t runs from April t until March t+1.

The remaining part of emission allowances will then be auctioned, with the auctioning rights shared among Member States[2]. More specifically, 90 % of these auctioning rights are distributed among Member States in shares that are identical to their proportion of verified emissions under EU ETS for 2005 (or the average of the period 2005-2007, whichever is the highest), whereas a further 10 % is divided between Member States with a relatively low per capita income – a so-called solidarity mechanism (EU, 2020).

Chart 10 shows the latest available national revenue figures from the auctioning of emission allowances. In that sense, it should be noted that Member States are obliged to inform the European Commission as to how they will use the revenue. They need to use at least half of the auction proceeds to reduce GHG emissions, to mitigate and adapt to climate change (EC, 2015).

The efficiency of EU ETS in terms of reducing GHG emissions depends on the price of a European emission allowance (EUA). However, since 2009, a surplus of emission allowances has built up – largely due to the

1 Carbon leakage means that, for reasons of costs related to climate policies, businesses will transfer their production to other countries with less emission constraints.
2 It should be noted that some European funds – like the Innovation and Modernisation Funds, both of which stimulate durable energy transition, also receive part of the auctioning allowances to cover their financing costs.

economic and financial crisis – leading to a low carbon price and a weak incentive to reduce emissions. As a long-term solution to this problem, the European Commission introduced the Market Stability Reserve (MSR) which has effectively been in place since January 2019. The MSR effectively addresses the structural over-supply of allowances by automatically removing a percentage of the emission allowances from the market and putting it in a reserve if the total volume of emission allowances exceeds a certain threshold. Each year, the EU communicates on this excess supply allowing market participants to form expectations about the number of allowances that will be added to the MSR (EC, 2021b).

Since the first announcement of the introduction of the MSR, the price of an EUA seems to have increased gradually, implying that the MSR is an effective instrument in raising the efficiency of EU ETS. Moreover, as analysed by De Jonghe *et al.* (2020), the introduction of the MSR and thus the tightening of EU ETS regulations has raised the emission efficiency of polluting firms.

When it comes to taxing industry emissions, it is also worth mentioning that international maritime transport is not covered under the EU ETS. This sector can also benefit from an exemption from payment of excise duties for fossil fuels used as motor fuel or heating. However, if its emissions are compared with country-wide emissions, international shipping would be the world's 9th largest emitter of CO_2 (OECD, 2019). Recently, the European Commission proposed, as part of its Fit for 55 package[1], to gradually add international shipping to EU ETS starting from 2023.

The aviation sector also benefits from preferential treatment in terms of taxing carbon emissions. No excise duties have to be paid on the use of fuels, i.e. kerosene and the impact of EU ETS is very limited as only flights within the EEA are considered. Moreover, around 80 % of emission allowances for the aviation sector are provided for free (ECA, 2020). Again, it should be noted that initiatives under the Fit for 55 package also seek to strengthen the existing scope and rules for the aviation sector. In addition, in its budget agreement for 2022, the Belgian federal government decided to introduce an embarkation tax on airline passengers. But the precise details of this tax still need to be elaborated.

Taxing emissions in the electricity sector

The effective taxation of emissions from the use of primary combustible energy sources needed to generate electricity is also mainly determined by the EU ETS and thus by changes in the price of an EUA. In contrast to other sectors, there is no free allocation of emission rights to electricity generators, implying that the strong price rise of an EUA in recent years could have a significant impact on the cost of producing electricity.

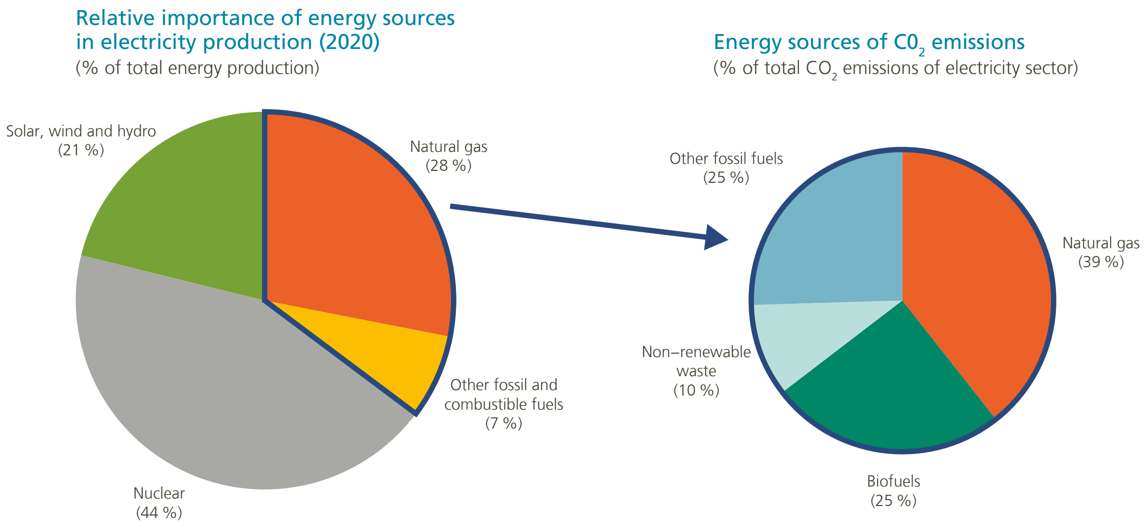
To analyse the impact of the price of an EUA on the average cost per MWh of electricity produced, it is necessary to take into account different factors, as is shown in figure 2. More specifically, four different elements should be combined: (i) the price of an EUA, i.e. the cost of emitting a tonne of CO_2, (ii) the amount of CO_2 emissions released by each primary energy source when used as an input in the electricity generation process, (iii) the efficiency of the electricity generation process in transforming each primary energy input source into electricity and (iv) the relative importance of each combustible energy source as an input for generating electricity (see chart 11).

To compute the average cost of CO_2 emissions by MWh of electricity produced for a specific energy source, it is worth noting that the volume of CO_2 emissions caused by the generation of one unit of electricity depends on the combination of two factors. The first factor is the amount of CO_2 released by each unit of input when used in the electricity generation process. It is a property determined by physics and specific to each energy source. The second factor is the efficiency of the technology used to transform that unit of energy input into electricity. In the case of electricity plants using natural gas as fuel, the efficiency is generally estimated to be

1 Initiatives linked to the European Green Deal, particularly including the climate target of a net reduction in GHG emissions of 55 %, are presented under the Fit for 55 package.

Chart 11

Electricity sector $C0_2$ emissions



Sources : Belgium's greenhouse gas inventory, CREG.

between 50 % and 60 %. It is the most efficient fossil technology ; other power plants generally hover around an efficiency ratio between 35 % and 40 % (Mira, 2019). Moreover, compared to most other fossil fuels, the use of natural gas as a primary energy source also leads to less CO_2 emissions per unit of energy used. Finally, when assuming that the cost of an EUA equals € 61, which was the price paid in mid-September 2021, and using the calculation approach illustrated in figure 2, one can estimate the average cost of emitting CO_2 by using natural gas as a primary energy source to be around € 22 per MWh of electricity produced. For other combustible energy sources the average cost per MWh electricity produced is higher. This is because of a lower efficiency rate in terms of electricity production and a higher CO_2 content of the fossil fuel. That cost could be

Figure 2

The average cost of CO_2 emissions for electricity producers

$$\text{Average } CO_2 \text{ Cost}_i = \text{Cost}_i^{CO_2} / \text{MWh}_i = \text{Price}^{CO_2} / \text{tonne}^{CO_2} \times \text{tonne}^{CO_2} / \text{Input}_i \times \text{Input}_i / \text{MWh}_i$$

Average cost of CO_2 emission by MWh produced from energy input i (i can be natural gas, waste, etc.)

- $\text{Price}^{CO_2} / \text{tonne}^{CO_2}$: Price per tonne CO_2 (EU ETS)
- $\text{tonne}^{CO_2} / \text{Input}_i$: CO_2 emissions by unit of energy input i
- $\text{Input}_i / \text{MWh}_i$: Electricity generation efficiency, reflecting the amount of energy input i needed to produce one MWh of electricity

$$\text{Average } CO_2 \text{ Cost}_{TOTAL} = \Sigma_i \left[\text{Cost}^{CO_2} / \text{MWh}_i \times \text{MWh}_i \,/ \text{MWh}_{TOTAL} \right]$$

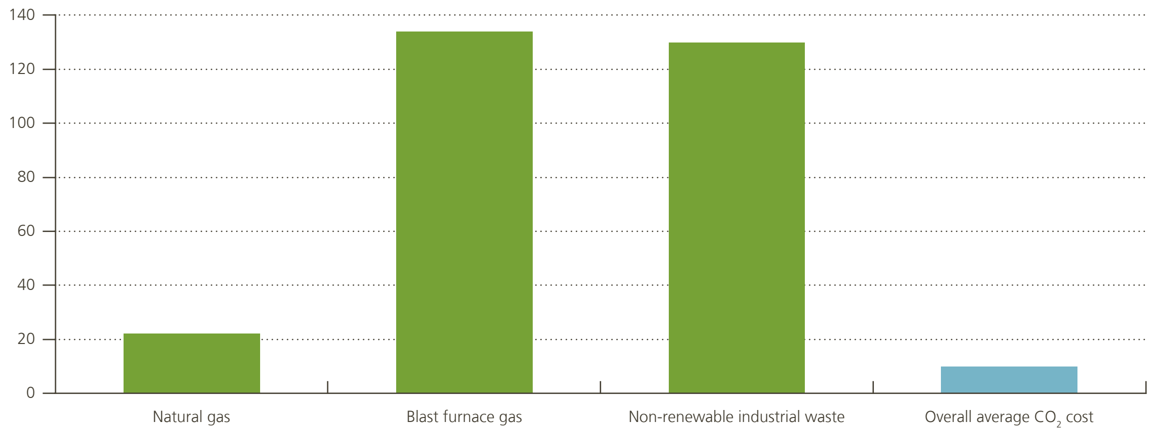
- $\text{Cost}^{CO_2} / \text{MWh}_i$: Average cost of CO_2 emission by MWh produced from input i
- $\text{MWh}_i / \text{MWh}_{TOTAL}$: Share of electricity produced from fuel input i in the total electricity production

Source : NBB.

Chart 12

Estimated average cost of EU ETS per MWh of electricity production[1]

(€ per MWh of produced electricity)



Sources: Eurostat, NBB.
1 With EU ETS price of CO_2 per tonne of € 61.

higher than € 100 per MWh for electricity produced using Blast furnace gas or non-renewable industrial waste for instance. To estimate the overall average cost of CO_2 by MWh of electricity produced, we need to weigh the average cost of CO_2 emissions by MWh produced for all different primary energy input sources by their share in the total production of electricity (see the second expression in figure 2). This requires detailed information for each combustible energy source used as an input for electricity generation. Using the energy balance for Belgium published by Eurostat, and taking into account electricity produced from other energy sources that emit (almost) no CO_2 (solar, wind, nuclear, …) and/or that are not covered by EU ETS (biomass, municipal waste, …), the overall average cost is estimated around € 10 per MWh.

Finally, it is important to stress that the impact of EU ETS, and thus the price of an EUA, on consumer electricity prices is different from this average cost because consumer prices are largely influenced by the market price of electricity. Many additional factors come into play here, which makes a precise estimate highly complex. A general feature, however, is that the market price for electricity is most of the time determined by the marginal production price of electricity generated by natural gas plants[1]. As gas plants have to buy emission allowances to cover their CO_2 emissions, their marginal production cost is affected by the EUA price. As a result, the impact of EU ETS on the energy content of final consumer prices is probably higher than the overall average cost and more in line with our estimated average cost per MWh for electricity produced using natural gas.

3.2 Expenditure-based instruments

Besides the above-mentioned instruments on the revenue side, targeted spending can also correct the price signal and encourage the reduction of greenhouse gas emissions (see section 1.1). Public spending to mitigate climate change can be understood with the help of the Classification of the Functions of Government (COFOG). This classification notably makes it possible to identify expenditure devoted to environmental protection, of which pollution abatement is a sub-category that accounted for € 2.8 billion worth of expenditure by Belgium in 2019.

1 A short and simplified explanation of the price-setting mechanism for electricity based on the "merit order" of the different technologies can be found on https://www.febeg.be/fr/merit-order.

Green certificates : an incentive that proves difficult to balance

The bulk of this spending, € 2.4 billion, took the form of subsidies granted via the green certificate system. From 2002 on, the federal government and the three Regions drew up mechanisms of this type, with a view to encouraging production of renewable energy. Green certificates are securities granted by the authorities to green power generators, that are supposed to speed up the investment payback time for these clean sources of energy. Typically, that concerns households who invest in the installation of photovoltaic solar panels. Green power generators are given certificates by the public authorities, in proportion to their production, that they can cash in with energy suppliers (against a guaranteed minimum price). Suppliers effectively need these certificates to meet their obligation to pass on a certain quota to the public authorities, de facto guaranteeing the supply of a corresponding quantity of green electricity. In return for that, electricity suppliers have the option of passing the costs of green certificates on to their customers' bills.

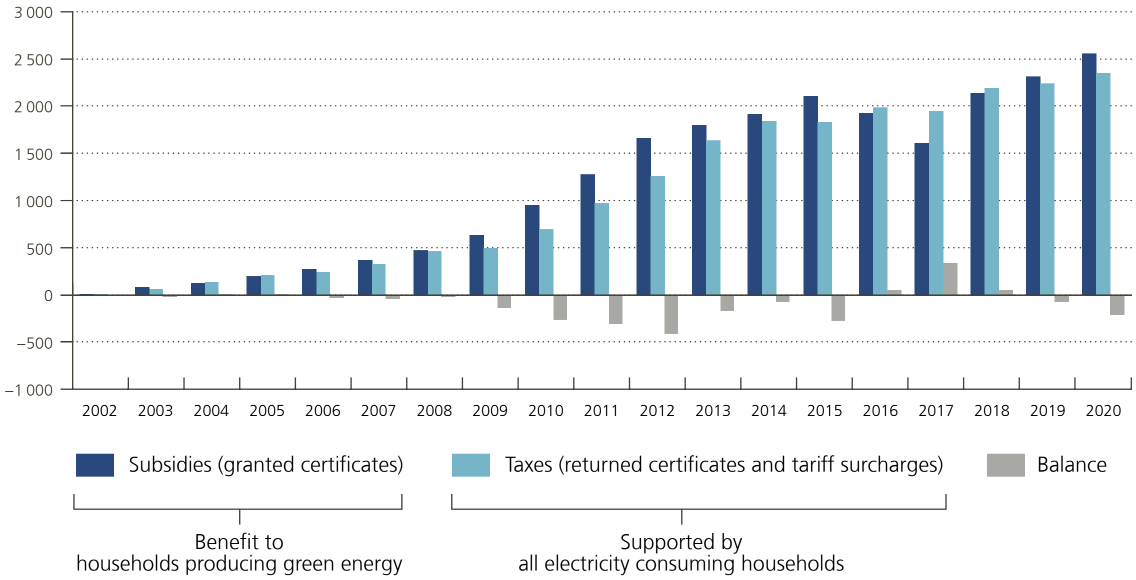
In this context, there is no cash flow passing through government accounts. But the system has an important mandatory redistribution component (between consumers and producers of green energy), which according to the official national accounting rules (ESA) for the statistical recording of these transactions is considered as a typical government function. So, from a statistical point of view, the green certificate mechanism boils down to a system whereby the public authorities grant subsidies to green power generators and levy taxes on electricity suppliers. The subsidies presented in this section are therefore counterbalanced by taxes collected.

In principle, this mechanism should be neutral for the State budget. In practice, however, that has not always been the case. From 2009-2010 onwards, a big gap has been observed between the level of spending on and revenue from green certificates. Both in Flanders and in Wallonia, the system soon became a victim of its own success. The attraction of photovoltaic solar energy has led to an over-supply of green certificates offered by producers in relation to the limited demand from energy suppliers. In these circumstances, it is the transmission system operator (Elia) that is under the obligation to buy back surplus certificates at a guaranteed price, and

Chart 13

Budgetary impact of the green certificate system

(cumulation of Flemish, Walloon, Brussels and federal schemes, in € million)



Sources : NAI, NBB.

this is what has happened in practice. The transmission system operator can in turn pass this cost on to the consumer's bill, but this tariff surcharge has often not been enough to balance the mechanism's books. That has led to recurrent deficits, both in Flanders and in Wallonia. Meanwhile, adjustments have been made at the level of regional schemes, like scrapping grants of green certificates to new domestic installations or the introduction of additional taxes. These measures have helped re-establish some form of budget balance, at least temporarily. The green certificates nevertheless still come with a heavy debt burden at the moment, especially on the Walloon side. This debt comes on top of the cost of the schemes that energy consumers have already had to bear, either in the form of taxes and surcharges, or from suppliers passing on the cost of the certificates in their electricity bills. These liabilities will inevitably have to be met in the future, at the taxpayers' expense.

So far, the public expenditure that has accumulated since 2002 in the various green certificate schemes comes to as much as € 22 billion. This begs the question of the very relevance of these mechanisms: is the heavy bill for green certificates justified in terms of the desired objectives and results obtained in terms of production of renewable energy? The literature devoted to this question suggests that these schemes may have cost more than was necessary. A recent study on the scheme in Flanders concludes for example that start-up aid for investment in solar panels cost twice as little as the recurrent grants of green certificates for solar panel production (De Groote and Verboven, 2019). The authors show that the beneficiaries of green certificates largely opt to receive the subsidies immediately: they apparently underestimate the future savings on energy bills or do not entirely trust the government to pay out future subsidies. Another study analyses a French scheme, with a guaranteed price of € 0.18 per KWh for all households who want to install solar panels on their roof [1]. It deduces a very high price for each tonne of CO_2 saved: € 304, to be compared with the value of one tonne of CO_2 less, currently estimated at around € 60 under the ETS system (Gollier *et al.*, 2021). All this appears to indicate that government intervention has not been optimal and could have been more efficient. Moreover, De Groote *et al.* (2016) show that it is the well-off households that have benefited more from green certificates. Not because of their higher incomes as such, but rather because they are more likely to take on board solar panels as major users and more frequent owners because they live in houses that are better adapted to their installation.

The experience with support schemes for solar panels and their shortcomings underlines the importance of designing support mechanisms that do not favour technological choices but rather focus on the contribution to the aim of reducing the carbon footprint. The extent of public support should be proportional to that aim. It also highlights the risks associated with mechanisms involving recurrent costs that are difficult to forecast accurately at the start. Such a renewed approach should ideally lead to relatively more support for other technologies such as heat pumps. Wide use of heat pumps [2], especially in residential heating systems, is often mentioned as a key element in reducing the carbon footprint of heating (see, for instance, IMF, 2021; Gollier *et al.*, 2021; SERV, 2021; or IEA, 2020). In many cases, the use of heat pumps is more expensive than conventional alternatives because of a high initial capital cost and because relative running costs are much higher, especially in Belgium where consumer prices for electricity are very high relative to natural gas. An increase in carbon taxes for natural gas used for heating and/or a reduction in surcharges on electricity could reduce that gap and help make alternative technologies more equally attractive (specific electricity tariffs and meters for houses equipped with efficient technologies such as heat pumps could also make a contribution). To address the issue of high initial capital costs, public authorities could resort to subsidies. In Belgium, the three Regions provide subsidies of this kind [3]. Nevertheless, current public support is relatively low compared to other technologies. In Flanders, specific subsidies for heat pumps amounted to € 3.8 million in 2020 or 8 % of the total energy subsidies granted. In Brussels, less than € 5 000 from a total budget of € 17 million was allocated to heat pumps for heating in 2019, the last year for which statistics are available. What is more, the subsidy that is most widely used, and

1 By way of comparison, in Flanders, the system provided for a subsidy of € 0.45 per kWh when it was launched in 2006, a rate which gradually came down to € 0.09 for solar panel owners who had joined the system at the end of 2012 (De Groote and Verboven, 2019).

2 Heat pumps rely on electricity to extract renewable energy from the air, from the ground or from water. They do that with an efficiency rate of 300 %: one unit of electricity energy produces 3 unit of heat (to be compared with 1.1 unit of heat in the case of the best condensing gas boiler). In theory, the technology is therefore more energy/CO_2 efficient than condensing gas boiler, even when the electricity is generated with natural gas.

3 Information on existing subsidies can be found on www.energiesparen.be for Flanders, on www.energie.wallonie.be for Wallonia and www.brugel.be for Brussels.

that eats up 26 % of the total budget for energy subsidies, is the subsidy for new condensing gas boilers for space heating. Between 2019 and 2021 the subsidy policies for heat pumps remained relatively stable in the three Regions, with a potential financial support between € 300 and about € 8000 depending on the technology used, the localisation, or the income level of the beneficiaries. In the coming years, regulations relative to the interdiction of heating oil or even natural gas as heating sources are expected to increase the share of installed heat pumps, provided they are accompanied by adequate support [1].

Finally, it should be pointed out that a lot of expenditure contributing, among other objectives, to reduce greenhouse gas emissions is still recorded in various functional classes not directly related to environmental protection. For instance, as far as mobility is concerned, the Infrabel budget should be considered as well as that of regional transport operators, which are an integral part of the general government sector, or the subsidies and investment aids given to the Belgian railway company SNCB. As regards capital spending, a potential boost can be expected from the National Recovery and Resilience Plan that Belgium submitted to the European Commission in June.

Recovery Plans: a potential boost for green investment

To help meet climate targets, reducing greenhouse gas emissions is a key concern of the Next Generation EU programme, which finances the EU Member States' national plans through the Recovery and Resilience Facility (RRF). Firstly, each country has to devote at least 37 % of this European budget to climate action. Moreover, the planned investment has to be in line with the country-specific recommendations, which include instructions regarding the green transition, while ensuring that none of the projects considered individually has any significant adverse impact on the environmental objectives (concerning climate change, biodiversity, pollution, the circular economy and water and marine resources).

As far as Belgium is concerned, the proportion of "green" spending included in the National Recovery and Resilience Plan ratified by the EU Council of Ministers is estimated to be 50 %, which accounts for around € 3 billion of the projected € 5.9 billion. The vast majority of climate-related projects can be found in the plan's pillars 1 (Climate, sustainability and innovation) and 3 (Mobility). More specifically, the plan covers a lot of investment in renovation of public buildings, implementation of the hydrogen energy option and a good many cycling path and rail infrastructure development projects.

This expenditure will be spread out over time, scheduled up until 2026. Consequently, the corresponding "green" sum comes to about € 500 million each year, which is still relatively modest in relation to the State budget. That is undoubtedly the reason why these EU-financed projects are backed up by other projects put forward by the Regions and the federal authorities, because each of these entities has their own recovery plan that sometimes exceeds the amount of the European budget allocated to it. The green dimension is certainly there in these additional plans, although difficult to estimate at this stage.

4. Redistribution issues for households

The existing taxation of energy products does not affect all households equally in proportion to their income or consumption level. And the same is true for any reform of indirect taxation involving an explicit carbon tax.

1 The commercialisation of oil boilers will be forbidden from 2030 onwards in Wallonia, and from 2025 in Brussels. In Flanders they cannot be installed anymore in new buildings since January 2021, and from 2022 onwards they will no longer be permitted in existing buildings as replacement of older boiler if a connection to the natural gas network is possible. Moreover, according to the new measures added in November 2021 to the Flemish Energy and Climate Plan 2021-2030, owners of new buildings will be required to install a (hybrid) heat pump from 1 January 2023 onwards, and from 2026 they will no longer be allowed to connect to the natural gas grid.

How the effort is split among the population is important to be able to correct social distortions that could lead to opposition to reforms targeted at lower emissions using the indirect taxation lever to manage the price signals.

The consumption share of transport fuel is lower for low-income households

The Household Budget Survey for Belgium makes it possible to identify four income classes. It reveals that households in the lowest income quartile devote a lower share of their consumption to transport fuels than the other, richer, households. This means that additional taxes on transport fuels would generally be progressive, i.e. the richer will on average be proportionally taxed more than the poorer households, which is a good thing in terms of social equity. However, it is also interesting to analyse whether the same distribution holds across the three Belgian Regions, which have very different characteristics, not least with respect to urban planning and infrastructure. Brussels is mostly urban, whereas the other two Regions have consumers in urban and rural areas, with a higher share of rural households in Wallonia. In Brussels, transport fuel is used less because distances are shorter and alternative transport modes are more widely available (public transport, cycling, walking). Only in the higher income category is the share of transport fuels higher than the average of the region. This could tentatively be explained by the equipment (more than one car, larger cars), by higher demand for individual transport for leisure purposes, or by geography if richer households are more peripherally located (more affluent neighbourhoods are often found on the outskirts of Brussels).

In contrast, Wallonia, and to a lesser extent Flanders, devote a higher share of consumption to transport, a trend that can be linked to higher demand for private motorised transport in more rural or peripheral locations. Demand from low-income groups is lower than the three other groups that all have a similar share.

Diversity within each income group implies that consumers within an income group do not face the same cost structure for transport fuel, as illustrated by the differences between regions with different rural/urban characteristics. This is also the case for other energy sources such as electricity, gas and heating oil.

The share of electricity consumption is higher for low-income households

For Belgium as a whole, the share of electricity consumption in total consumption clearly declines with income. This means that an additional (carbon) tax on electricity would be regressive.

From a geographical angle, the decreasing share of electricity consumption with income holds for Wallonia and Flanders, but less so for Brussels, where that share is lower and similar between income groups. There is no straightforward explanation for these observations because the data presented do not enable any distinction between electricity consumption for heating and electricity for other uses (hot water, cooking, lighting and other electric appliances). The better off the household, the more it tends to intensify its use of energy-consuming services.

Given that electricity consumption is highly dependent on the household's available equipment running on electricity (heating, hot water boilers, cookers, number of electrical appliances), the horizontal heterogeneity between households in the same income category is therefore extremely high and can even be higher than between income categories, as described in Douenne (2020).

Electricity is not the main fuel used for heating, usually being far less common than gas or heating oil. With the more recent growing awareness of the importance of energy performance of buildings, electricity is making a comeback as a primary heating source for high-quality buildings. The tandem of well-insulated buildings and technologically more mature heat pumps – that rely on electricity – is now seen as an efficient solution for buildings. Therefore, electricity is likely to become more important in the consumption basket so that redistribution aspects of electricity pricing will require renewed attention in the future.

Chart 14

Energy consumption as a share of total consumption, per income quartile

(2018, in %)

Sources: Household Budget Survey, Statbel.

The share of natural gas and heating oil consumption is higher for low-income households

The share of heating in the consumption basket of households (natural gas and heating oil) clearly declines with income in Belgium. This holds for the three Regions, but with differences in the fuel mix between gas and heating oil.

People from lower income groups have to allocate a larger part of their income for the purpose of heating. At least in the short run, there is a large incompressible part for this type of consumption. Although higher income groups can allocate a smaller share of their consumption to heating, their consumption is usually higher in terms of energy used. With higher incomes, they are able to lift the budget constraint on energy use (Cayla *et al.*, 2011).

The share of consumption allocated to natural gas is particularly high for low‑income households and especially in Brussels. In the Brussels‑Capital Region, the share of gas in energy consumption is systematically higher than in Flanders and in Wallonia. This is related to the availability of natural gas, which is widespread in urban areas, and virtually inexistent in many rural areas. The picture for heating oil backs up the consumption profile for gas. Where natural gas is not available, the main alternative is heating oil, and therefore the share of consumption of that fuel is significantly high in Wallonia. It is lower in Flanders, and very low in Brussels where natural gas is virtually available everywhere.

Our regional analysis indicates that differences across Belgian Regions are related to characteristics of rural and urban areas. This seems to confirm microeconomic research findings that energy consumption is characterised by significant horizontal heterogeneity in terms of energy mix and energy intensity, with differences within an income group often exceeding those between income groups. In a paper on the redistributive effect of green taxation in France, which relies on the micro data from the Household Budget Survey, Douenne (2019) finds that the horizontal heterogeneity is significant and largely due to households' equipment. Rural areas rely more on heating oil for heating, and on diesel for transport.

Lower income groups live in less insulated houses

Energy consumption is linked to the type and quality of household equipment. There are indications that the quality of equipment is linked to income. For instance, based on data for Flanders, it can be illustrated that households from the lower income quintile are systematically less well equipped than the higher income groups in term of glass, roof, pipe, wall or floor insulation, and that they are less well equipped with economical boilers or renewable energy.

Households from the lower income groups are mostly not able to make the investment in higher‑performing equipment that would help them to reduce their energy bills. Many households are constrained in terms of access to capital. The Woonsurvey (Heylen and Vanderstaeten, 2019) estimates that 50 % of households in Flanders do not have sufficient financial wealth to pay for a deep "energy‑efficient" renovation of their dwelling.

Chart 15

Full or partial presence of insulation in homes, per income quintile

(Flanders, 2018, in %)

Sources: Woonsurvey 2018 (Heylen and Vanderstaeten, 2019).

Carbon taxation needs to be accompanied by additional measure to compensate distributional issues

Because many households in the lower part of the income distribution are financially constrained, they will not be able to cushion their reduced purchasing power following the introduction of carbon taxes. That risks leading to welfare loss. Principally, social policy should focus on general income support that compensates for the (adverse) income effect from carbon emission price rises, while preserving the substitution effect that makes carbon emissions relatively more expensive. This could be accompanied by easier and cheaper access to capital and subsidies in favour of efficient technologies.

The design of efficient accompanying measures with a substantial budget will be a delicate mission. Given the significant heterogeneity within income groups, the identification of potential "losers" and "winners" of the pricing of pollution is difficult, which implies that measures should ideally not only be based on the income of recipients. The government will also have to contribute to the provision of infrastructure that facilitates the use of less (polluting) energy. Moreover, any additional measures should prevent opportunistic behaviour (misuse of subsidies, windfall effects, etc.), and special attention is required to prevent or limit the size of the probable rebound effect. Many authors (for instance, Cayla *et al.*, 2011 ; SERV, 2021 ; EC, 2020 or Bartiaux *et al.*, 2006) stress that a trend towards catching up with the level of comfort of the middle class is probable and risks partially compensating the targeted emission reduction.

Concluding remarks

Limiting global warming to 2 °C and preferably to 1,5 °C above pre-industrial levels requires a significant drop in global GHG emissions. To reach these targets, additional government measures are necessary as current climate mitigation policies are insufficient. Market-based or fiscal policy instruments are crucial in a government's toolbox. By increasing the relative price of pollution, they provide polluters with market incentives to reduce pollution and promote energy efficient technologies, if emissions are priced adequately.

Ideally, environmental tax instruments should have the actual level of pollution as their tax base such that the tax can be linked directly to the level of pollution. However, when it comes to taxing the use of combustible energy sources in Belgium, a direct carbon tax is not present. Based on existing Belgian fiscal instruments, an indirect price signal could be calculated.

In Belgium, there is ample room for increasing the effectiveness of CO_2 taxation. Emissions from road transport are taxed relatively high, but the resulting price signal is disturbed by the beneficial tax treatment of company cars. Especially in combination with a company fuel card, the cost of driving is fully externalized implying that the cost of pollution is not borne by the final polluter. Concerning household heating, effective CO_2 rates are close to zero, and among the lowest in Europe. Industry emissions' CO_2 price is solely determined by the European Emission Trading System (EU ETS), of which the price has recently shoot up to more than € 60 per tonne CO_2. The EU ETS also applies to the production of electricity. With the current mix of energy sources used for electricity production, the overall average cost from EU ETS of electricity production is limited to approximately € 10 per MWh.

The unequal taxation of CO_2 emissions across sectors and activities proves that, apart from a general tax shift towards environmental taxes, a tax shift within greenhouse gas related levies is desirable to make them more neutral with regard to greenhouse gas emissions. Basides promoting the most efficient emission reduction technology, this is important to create a level playing field that avoids free riding.

When making use of subsidies to steer consumers' or producers' behaviour, it is equally important to give a central place to the effective cost per ton of CO_2 emission reduction. From subsidies for solar panels, for example, it became clear that upfront investment subsidies are much more efficient than subsidies on future energy production. The efficient use of subsidies also benefits from carbon tax neutrality. For example, subsidies for heat pumps making use of electricity would see their effectiveness increase if the price of natural gas would rise relative to the electricity price.

Given the unequal share of energy consumption across household income quartiles, with the lower incomes generally consuming higher shares of energy, it is important to watch the distributional impact of carbon related taxes and subsidies. Compensations for those low-income groups that are proportionally most hit by rising energy prices are warranted. Yet, compensation should preferably come in the form of general income support that does not distort the carbon price signal, rather than support that reduces the energy price. Further, it is crucial for the government to contribute to the provision of the necessary infrastructure that facilitates the use of alternative energy sources. The advantage of carbon taxation, in comparison with subsidies, is that it raises money that – among other things – can be used to compensate the least well off. Subsidies on new green technologies often benefit higher income households more, as turned out to be the case with support for solar panels. Their adverse impact on the income distribution should be compensated elsewhere in the overall benefit and tax system.

Finally, increases in environmental tax revenues should be wisely used in view of all government objectives, without earmarking. This means that a rise in environmental tax revenues could be used to finance an increase in social benefits, as well as a reduction in labour taxation that increases labour market participation, or a reduction of the budget deficit that benefits future generations, or something else. Analogously, subsidies from greener electricity production should not necessarily be financed with taxes or levies on electricity consumption, but rather from the general budget means. This should ensure that any budgetary decision is justified in its own right, and not coupled to other decisions.

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